

Table of Contents

1.0 INTRODUCTION 1-1

1.1 EPA Certification Decision Conditions 1-3

1.2 Applicable Regulations 1-5

1.2.1 40 CFR Part 191 1-5

1.2.2 40 CFR Part 194 1-6

1.2.3 Compliance Application Guidance for 40 CFR Part 194 1-8

1.2.4 Guidance to the U.S. Department of Energy on Preparation for Recertification of the Waste Isolation Pilot Plant with 40 CFR Parts 191 and 194..... 1-9

1.3 Project Background 1-9

1.4 Site Selection Process..... 1-10

1.5 Program for Evaluating Long-Term Performance 1-12

1.6 Compliance Recertification Application Synopsis..... 1-15

1.7 Summary of Changes Since the CCA..... 1-17

REFERENCES 1-27

2.0 SITE CHARACTERIZATION..... 2-1

2.1 Geology..... 2-11

2.1.1 Data Sources 2-12

2.1.2 Geologic History..... 2-14

2.1.3 Stratigraphy and Lithology in the Vicinity of the WIPP Site 2-17

2.1.3.1 General Stratigraphy and Lithology below the Bell Canyon..... 2-21

2.1.3.2 The Bell Canyon Formation 2-22

2.1.3.3 The Castile Formation 2-24

2.1.3.4 The Salado 2-28

2.1.3.5 The Rustler..... 2-36

2.1.3.6 The Dewey Lake Redbeds Formation 2-50

2.1.3.7 The Santa Rosa 2-53

2.1.3.8 The Gatuña Formation..... 2-53

2.1.3.9 Mescalero Caliche..... 2-55

2.1.3.10 Surficial Sediments 2-57

2.1.3.11 Summary 2-58

2.1.4 Physiography and Geomorphology 2-58

2.1.4.1 Regional Physiography and Geomorphology 2-59

2.1.4.2 Site Physiography and Geomorphology 2-59

2.1.5 Tectonic Setting and Site Structural Features..... 2-63

2.1.5.1 Tectonics..... 2-63

2.1.5.2 Loading and Unloading 2-66

2.1.5.3 Faulting..... 2-69

2.1.5.4 Igneous Activity..... 2-69

2.1.6 Nontectonic Processes and Features 2-71

2.1.6.1 Evaporite Deformation 2-71

2.1.6.2 Evaporite Dissolution 2-76

2.2 Surface Water and Groundwater Hydrology 2-81

2.2.1	Groundwater Hydrology	2-83
2.2.1.1	Conceptual Models of Groundwater Flow.....	2-89
2.2.1.2	Units Below the Salado	2-91
2.2.1.3	Hydrology of the Salado.....	2-95
2.2.1.4	Units Above the Salado	2-99
2.2.1.5	Hydrology of Other Groundwater Zones of Regional Importance	2-123
2.2.2	Surface-Water Hydrology.....	2-128
2.3	Resources	2-134
2.3.1	Extractable Resources.....	2-135
2.3.1.1	Potash Resources at the WIPP Site.....	2-135
2.3.1.2	Hydrocarbon Resources at the WIPP Site	2-136
2.3.1.3	Other Resources.....	2-140
2.3.2	Cultural and Economic Resources.....	2-140
2.3.2.1	Demographics	2-140
2.3.2.2	Land Use.....	2-143
2.3.2.3	History and Archaeology.....	2-144
2.4	Background Environmental Conditions.....	2-147
2.4.1	Terrestrial and Aquatic Ecology	2-148
2.4.1.1	Vegetation.....	2-149
2.4.1.2	Mammals	2-150
2.4.1.3	Reptiles and Amphibians	2-150
2.4.1.4	Birds.....	2-150
2.4.1.5	Arthropods	2-151
2.4.1.6	Aquatic Ecology	2-151
2.4.1.7	Endangered Species	2-151
2.4.2	Water Quality.....	2-152
2.4.2.1	Groundwater Quality	2-152
2.4.2.2	Surface Water Quality	2-154
2.4.3	Air Quality	2-154
2.4.4	Environmental Radioactivity	2-155
2.4.4.1	Atmospheric Radiation Baseline	2-155
2.4.4.2	Ambient Radiation Baseline	2-156
2.4.4.3	Terrestrial Baseline	2-156
2.4.4.4	Hydrologic Radioactivity.....	2-156
2.4.4.5	Biotic Baseline.....	2-159
2.5	Climate and Meteorological Conditions	2-159
2.5.1	Historic Climatic Conditions	2-160
2.5.2	Recent Climatic Conditions	2-162
2.5.2.1	General Climatic Conditions	2-162
2.5.2.2	Temperature Summary	2-163
2.5.2.3	Precipitation Summary	2-163
2.5.2.4	Wind Speed and Wind Direction Summary	2-163
2.6	Seismology.....	2-164
2.6.1	Seismic History.....	2-180
2.6.2	Seismic Risk	2-182

	2.6.2.1	Acceleration Attenuation	2-182
	2.6.2.2	Seismic Source Zones	2-183
	2.6.2.3	Source Zone Recurrence Formulas and Maximum Magnitudes.....	2-183
	2.6.2.4	Design Basis Earthquake	2-186
REFERENCES			2-188
3.0	FACILITY DESCRIPTION		3-1
3.1	General Facility Design		3-3
	3.1.1	DOE Facility Acquisition Process	3-7
	3.1.2	Configuration Control.....	3-8
	3.1.3	Surface Structures	3-9
3.2	Repository Configuration.....		3-11
3.3	Engineered <i>Disposal-System</i> Barriers		3-13
	3.3.31	Backfill <i>MgO</i> Engineered Barrier.....	3-14
		<i>3.3.1.1 Change of MgO Supplier</i>	3-16
		<i>3.3.1.2 Elimination of MgO Minisacks</i>	3-17
	3.3.21	Shaft Seals.....	3-17
		3.3.21.1 Site Setting.....	3-18
		3.3.21.2 Design Objectives	3-18
		3.3.21.3 Design Description	3-18
		3.3.1.4 Materials	3-22
		3.3.1.5 Structural Analysis.....	3-23
		3.3.1.6 Hydrologic Evaluations	3-25
	3.3.32	Panel Closure System	3-27
	3.3.4	Borehole Plugs.....	3-32
REFERENCES			3-37
BIBLIOGRAPHY.....			3-40
4.0	WASTE DESCRIPTION.....		4-1
4.1	Waste Inventory		4-3
	4.1.1	Sources of TRU Waste.....	4-6
	4.1.2	TRU Waste Generator and Storage Sites	4-7
	4.1.3	TRU Waste Inventory	4-12
		4.1.3.1 Inventory Terminology	4-15
		4.1.3.2 Nonradionuclide Inventory Roll- <i>Up</i>	4-21
		4.1.3.3 Radionuclide Inventory Roll- <i>Up</i>	4-29
4.2	Waste Components and Characteristics.....		4-33
	4.2.1	Identification and Qualification	4-33
	4.2.2	Repository Limits.....	4-35
	4.2.3	Waste Container Limits	4-38
4.3	Waste Controls.....		4-42
	4.3.1	Load Management	4-42
	4.3.2	WIPP Waste Information System	4-43
	4.3.3	Quality Assurance.....	4-46
		4.3.3.1 Performance Demonstration Programs	4-49
4.4	Waste Characterization		4-50

4.4.1	Qualitative Methodologies.....	4-55
4.4.1.1	Acceptable Knowledge.....	4-55
4.4.1.2	Nondestructive Examination.....	4-58
4.4.1.3	Visual Examination.....	4-60
4.4.2	Quantitative Methodologies.....	4-60
4.4.2.1	Nondestructive Assay.....	4-61
4.4.3	<i>Additional Change to the Waste Characterization Program</i>	4-62
REFERENCES	.....	4-63
5.0	<i>QUALITY ASSURANCE</i>	5-1
5.1	<i>Introduction</i>	5-1
5.1.1	<i>Mission and Policy</i>	5-1
5.1.2	<i>Quality Assurance Program History</i>	5-2
5.2	<i>Quality Assurance Program Requirements</i>	5-2
5.2.1	<i>Requirements in the Code of Federal Regulations</i>	5-2
5.2.1.1	<i>40 CFR Part 194</i>	5-2
5.2.1.2	<i>40 CFR § 194.22, Quality Assurance</i>	5-2
5.2.2	<i>Other Requirements and Standards</i>	5-3
5.3	<i>Incorporation of 40 CFR § 194.22 Criteria in the QAPD</i>	5-3
5.3.1	<i>Criterion 1 – Organization</i>	5-3
5.3.2	<i>Criterion 2 – Quality Assurance Program</i>	5-5
5.3.2.1	<i>Quality Assurance Program Overview</i>	5-5
5.3.2.2	<i>Grading</i>	5-6
5.3.2.3	<i>Quality Assurance Program Documents</i>	5-7
5.3.2.4	<i>Qualification and Training</i>	5-7
5.3.2.5	<i>Management Assessments</i>	5-8
5.3.3	<i>Criterion 3 – Design Control</i>	5-8
5.3.4	<i>Criterion 4 – Procurement Document Control</i>	5-8
5.3.5	<i>Criterion 5 – Instructions, Procedures, and Drawings</i>	5-8
5.3.6	<i>Criterion 6 – Document Control</i>	5-9
5.3.7	<i>Criterion 7 – Control of Purchased Items and Services</i>	5-9
5.3.8	<i>Criterion 8 – Identification and Control of Items</i>	5-10
5.3.9	<i>Criterion 9 – Control of Processes</i>	5-10
5.3.10	<i>Criterion 10 – Inspection</i>	5-11
5.3.11	<i>Criterion 11 – Test Control</i>	5-11
5.3.12	<i>Criterion 12 – Control of Measuring, Monitoring, Data Collection and Test Equipment</i>	5-12
5.3.13	<i>Criterion 13 – Handling, Storage, and Shipping</i>	5-12
5.3.14	<i>Criterion 14 – Inspection, Test, and Operating Status</i>	5-13
5.3.15	<i>Criterion 15 – Control of Nonconforming Items</i>	5-13
5.3.16	<i>Criterion 16 – Corrective Action</i>	5-14
5.3.17	<i>Criterion 17 – QA Records</i>	5-14
5.3.18	<i>Auditor and Technical Specialist Skills and Background</i>	5-15
5.3.19	<i>Criterion 18 – Audits and Surveillances</i>	5-16
5.3.20	<i>Criterion 19 – Software Quality Assurance</i>	5-17
5.3.21	<i>Criterion 20 – Scientific Investigation</i>	5-18
5.3.22	<i>Criterion 21 – Data Quality Characteristics</i>	5-20

5.3.23	<i>Criterion 22 – Qualification of Data</i>	5-21
5.4	<i>The Carlsbad Field Office Quality Assurance Program Document</i>	5-22
5.4.1	<i>Purpose of the Quality Assurance Program Document</i>	5-22
5.4.2	<i>U.S. Environmental Protection Agency Requirements in the Quality Assurance Program Document</i>	5-22
5.4.3	<i>Use of the Graded Approach</i>	5-23
5.4.4	<i>Quality Assurance Program Document Implementation</i>	5-23
5.4.5	<i>Quality Assurance Program Document Changes</i>	5-23
5.4.6	<i>Quality Assurance Program Participant Support</i>	5-24
5.4.7	<i>Structure of the QAPD</i>	5-24
5.4.8	<i>Quality Assurance Program Document Crosswalk to NQA-1, -2, and -3 Requirements</i>	5-24
5.4.9	<i>CBFO Implementing Procedures</i>	5-25
5.5	<i>Applicability of the QA Program</i>	5-26
5.5.1	<i>Waste Characterization Activities and Assumptions</i>	5-27
5.5.2	<i>Environmental Monitoring, Monitoring of the Performance of the Disposal System, and Sampling and Analysis Activities</i>	5-28
5.5.3	<i>Design of the Disposal System and Actions Taken to Ensure Compliance with Design Specifications</i>	5-28
5.5.4	<i>Collection of Data and Information to Support Compliance Application(s)</i>	5-28
5.6	<i>Quality Assurance Program Adequacy, Implementation, and Effectiveness</i>	5-28
5.6.1	<i>Adequacy of the Quality Assurance Program</i>	5-29
5.6.2	<i>Implementation of the Quality Assurance Program</i>	5-29
5.6.3	<i>Effectiveness of the Quality Assurance Program</i>	5-29
5.7	<i>The Carlsbad Field Office Audit Process</i>	5-30
5.7.1	<i>Overview of the Carlsbad Field Office Assessment Processes</i>	5-30
5.7.2	<i>Auditor and Technical Specialist Independence</i>	5-31
5.7.3	<i>Audit History</i>	5-31
	REFERENCE	5-32
6.0	CONTAINMENT REQUIREMENTS	6-1
6.0.1	Introduction	6-1
6.0.2	Overview of Chapter 6.0	6-1
6.0.2.1	Conceptual Basis for the Performance Assessment	6-3
6.0.2.2	Undisturbed Performance	6-4
6.0.2.3	Disturbed Performance	6-7
6.0.2.3.1	Cuttings and Cavings	6-8
6.0.2.3.2	Spallings	6-8
6.0.2.3.3	Direct Brine Flow	6-9
6.0.2.3.4	Mobilization of Actinides in Repository Brine	6-9
6.0.2.3.5	Long-Term Brine Flow up an Intrusion Borehole	6-10
6.0.2.3.6	Groundwater Flow in the Culebra	6-11
6.0.2.3.7	Actinide Transport in the Culebra	6-12
6.0.2.3.8	Intrusion Scenarios	6-13
6.0.2.4	Compliance Demonstration Method	6-14

	6.0.2.5	Results of the Performance Assessment	6-14
6.1		Performance Assessment Methodology.....	6-15
	6.1.1	Conceptualization of Risk.....	6-17
	6.1.2	Characterization of Uncertainty in Risk	6-19
	6.1.3	Regulatory Criteria for the Quantification of Risk	6-22
	6.1.4	Calculation of Risk	6-25
	6.1.5	Techniques for Probabilistic Analysis	6-28
	6.1.5.1	Selection of Variables and Their Ranges and Distributions	6-28
	6.1.5.2	Generation of the Sample	6-29
	6.1.5.3	Propagation of the Sample through the Analysis.....	6-30
	6.1.5.4	Uncertainty Analysis.....	6-30
	6.1.5.5	Sensitivity Analysis	6-31
6.2		Identification and Screening of Features, Events, and Processes	6-31
	6.2.1	Identification of Features, Events, and Processes.....	6-32
	6.2.2	Criteria for Screening of <i>to Screen</i> Features, Events, and Processes and Categorization of Retained Features, Events, and Processes.....	6-34
	6.2.2.1	Elimination of <i>Eliminating</i> Features, Events, and Processes Based on Regulation- (S-O-R) , Probability (S-O-P) , or Consequence- (S-O-C)	6-34
	6.2.2.2	Undisturbed Performance Features, Events, and Processes.....	6-35
	6.2.2.3	Disturbed Performance Features, Events, and Processes.....	6-35
	6.2.3	Natural Features, Events, and Processes.....	6-36
	6.2.4	Waste- and Repository-Induced Features, Events, and Processes.....	6-37
	6.2.5	Human-Initiated Events and Processes.....	6-46
	6.2.5.1	Historical, Current, and Near-Future Human Activities.....	6-52
	6.2.5.2	Future Human Activities.....	6-52
	6.2.6	<i>Reassessment of Features, Events, and Processes for the Compliance Recertification</i>	6-55
6.3		Scenario Development and Selection	6-55
	6.3.1	Undisturbed Performance	6-56
	6.3.2	Disturbed Performance	6-58
	6.3.2.1	The Disturbed Performance Mining Scenario	6-59
	6.3.2.2	The Disturbed Performance Deep Drilling Scenario.....	6-59
	6.3.2.3	The Disturbed Performance Mining and Deep Drilling Scenario.....	6-69
	6.3.3	Scenarios Retained for Consequence Analysis.....	6-72
6.4		Calculation of Scenario Consequences	6-72
	6.4.1	Types of Models	6-72
	6.4.2	Model Geometries.....	6-73
	6.4.2.1	Disposal System Geometry.....	6-74
	6.4.2.2	Culebra Geometry.....	6-75
	6.4.3	The Repository.....	6-75

6.4.3.1	Creep Closure	6-80
6.4.3.2	Repository Fluid Flow	6-82
6.4.3.3	Gas Generation	6-83
6.4.3.4	Chemical Conditions in the Repository	6-87
6.4.3.5	Dissolved Actinide Source Term.....	6-91
6.4.3.6	Source Term for Colloidal Actinides.....	6-96
6.4.4	Shafts and Shaft Seals.....	6-97
6.4.5	The Salado	6-99
6.4.5.1	Impure Halite	6-101
6.4.5.2	Salado Interbeds.....	6-102
6.4.5.3	DRZ	6-104
6.4.5.4	Actinide Transport in the Salado	6-106
6.4.6	Units Above the Salado	6-108
6.4.6.1	The Los Medaños Unnamed Lower Member	6-109
6.4.6.2	The Culebra.....	6-109
6.4.6.3	The Tamarisk.....	6-130
6.4.6.4	The Magenta	6-130
6.4.6.5	The Forty-niner	6-130
6.4.6.6	Dewey Lake	6-131
6.4.6.7	Supra-Dewey Lake Units.....	6-132
6.4.7	The Intrusion Borehole	6-132
6.4.7.1	Releases During Drilling	6-133
6.4.7.2	Long-Term Releases Following Drilling.....	6-138
6.4.8	Castile Brine Reservoir.....	6-141
6.4.9	Climate Change.....	6-146
6.4.10	Initial and Boundary Conditions for Disposal System Modeling.....	6-149
6.4.10.1	Disposal System Flow and Transport Modeling (BRAGFLO and NUTS).....	6-150
6.4.10.2	Culebra Flow and Transport Modeling (MODFLOW-2000-SECOFL2D , SECOTP2D).....	6-152
6.4.10.3	Initial and Boundary Conditions for Other Computational Models.....	6-153
6.4.11	Numerical Codes Used in Performance Assessment.....	6-154
6.4.12	Sequences of Future Events.....	6-160
6.4.12.1	Active and Passive Institutional Controls in Performance Assessment	6-160
6.4.12.2	Number and Time of Drilling Intrusions	6-161
6.4.12.3	Location of Intrusion Boreholes	6-163
6.4.12.4	Activity of the Intersected Waste.....	6-164
6.4.12.5	Diameter of the Intrusion Borehole	6-169
6.4.12.6	Probability of Intersecting a Brine Reservoir	6-169
6.4.12.7	Plug Configuration in the Abandoned Intrusion Borehole.....	6-171
6.4.12.8	Probability of Mining Occurring within the Land Withdrawal Area.....	6-171
6.4.13	Construction of a Single CCDF	6-172

6.4.13.1	Constructing Consequences of the Undisturbed Performance Scenario	6-172
6.4.13.2	Scaling Methodology for Disturbed Performance Scenarios	6-173
6.4.13.3	Estimating Long-Term Releases from the E1 Scenario..	6-174
6.4.13.4	Estimating Long-Term Releases from the E2 Scenario..	6-175
6.4.13.5	Estimating Long-Term Releases from the E1E2 Scenario	6-177
6.4.13.6	Multiple Scenario Occurrences.....	6-179
6.4.13.7	Estimating Releases During Drilling for All Scenarios..	6-179
6.4.13.8	Estimating Releases in the Culebra and the Impact of the Mining Scenario.....	6-181
6.4.13.9	Final Construction of a Single CCDF.....	6-181
6.4.14	CCDF Family.....	6-182
6.5	Performance Assessment Results	6-182
6.5.1	Demonstrating Convergence of the Mean CCDF.....	6-182
6.5.2	Complementary Cumulative Distribution Functions for the WIPP..	6-183
6.5.3	Release Modes Contributing to the Total Radionuclide Release	6-188
6.5.4	Uncertainty and the Role of Conservatism in the Compliance Demonstration.....	6-191
6.5.5	Summary of the Demonstration of Compliance with the Containment Requirements.....	6-192
	REFERENCES	6-195
7.0	ASSURANCE REQUIREMENTS.....	7-1
7.1	Active Institutional Controls.....	7-1
7.1.1	Requirements for Active Institutional Controls.....	7-5
7.1.2	Objectives for Active Institutional Controls.....	7-5
7.1.3	Implementation of the Active Institutional Controls Program	7-6
7.1.3.1	Analysis of Activities	7-7
7.1.3.2	Active Controls Design Features	7-21
7.1.3.3	Description of Active Institutional Controls Features	7-22
7.1.4	Effectiveness of the Active Institutional Controls Program	7-24
7.2	Monitoring	7-24
7.2.1	Monitoring Program Requirements	7-32
7.2.2	Monitoring Program Design	7-33
7.2.2.1	Significant Disposal System Parameters	7-33
7.2.2.2	Important Disposal System Concern	7-35
7.2.2.3	Meaningful Data in a Relatively Short Time.....	7-36
7.2.2.4	Preservation of Disposal System Integrity	7-36
7.2.2.5	Complementary With <i>Other Regulatory</i> RCRA Programs	7-43
7.2.3	Monitoring Program Description.....	7-43
7.2.3.1	Geomechanical Monitoring Program.....	7-45
7.2.3.2	VOC Confirmatory Monitoring Program	7-48
7.2.3.3	Groundwater Surveillance Program.....	7-50
7.2.3.4	Observation of Drilling Activities	7-51

	7.2.3.5	Subsidence Monitoring	7-52
	7.2.4	Reporting	7-53
	7.2.5	Compliance Monitoring Parameter Data Results	7-54
7.3		Passive Institutional Controls	7-55
	7.3.1	Requirements for Passive Institutional Controls	7-55
	7.3.2	Objectives for Passive Institutional Controls.....	7-56
	7.3.3	Implementation of the Passive Institutional Controls Program.....	7-56
	7.3.3.1	Definition of Passive Institutional Design Appropriate for the WIPP	7-59
	7.3.3.2	Implementation of Programs to Collect Information.....	7-70
	7.3.3.3	Passive Institutional Controls Timelines	7-70
	7.3.4	Effectiveness of Passive Controls in Reducing the Rate of Human Intrusion.....	7-76
	7.3.4.1	Expected Effectiveness	7-77
	7.3.4.2	Credit Taken in Performance Assessment Calculations	7-78
7.4		Multiple Barriers.....	7-80
	7.4.1	Requirements for Multiple Barriers.....	7-80
	7.4.2	Objectives for Multiple Barriers	7-81
	7.4.3	Implementation of Multiple Barriers	7-81
	7.4.3.1	Engineered Alternatives Cost and Benefit Study	7-81
	7.4.3.2	Incorporation into Repository Design.....	7-86
7.5		Resource Characteristics Evaluations <i>Considerations</i>	7-87
	7.5.1	Resource Considerations Prior to 40 CFR Parts 191 and 194.....	7-88
	7.5.2	Implementation of Resource Considerations.....	7-88
7.6		Waste Removal	7-89
	7.6.1	Requirements for Waste Removal	7-89
	7.6.2	Implementation of Waste Removal	7-90
	7.6.2.1	Planning and Permitting.....	7-90
	7.6.2.2	Initial Above Ground Setup and Shaft Sinking	7-91
	7.6.2.3	Underground Excavation and Facility Setup.....	7-91
	7.6.2.4	Waste Location and Removal Operations	7-91
	7.6.2.5	Closure and D&D of the Facility.....	7-91
		REFERENCES	7-92
8.0		INDIVIDUAL AND GROUNDWATER PROTECTION REQUIREMENTS.....	8-1
	8.1	Individual Protection Requirements	8-1
	8.1.1	Compliance Assessment of Undisturbed Performance.....	8-2
	8.1.2	Dose Calculation.....	8-5
	8.1.2.1	Transport Pathway	8-5
	8.1.2.2	Bounding Analysis.....	8-6
	8.1.3	Dose Calculation Results	8-7
	8.1.4	Statistical Assessment.....	8-9
	8.1.5	Parameter Values	8-10
	8.1.6	Summary of Compliance with the Individual Protection Standard	8-10
	8.2	Groundwater Protection Requirements.....	8-10
	8.2.1	Criteria for USDW Determination.....	8-12

8.2.1.1	Groundwater Quantity	8-13
8.2.1.2	Groundwater Quality	8-15
8.2.2	Comparison with USDW <i>Underground Source of Drinking Water</i> Determination Criteria	8-15
8.2.3	Comparison with the National Primary Drinking Water Standards ...	8-17
8.2.3.1	Transport Pathway	8-17
8.2.3.2	Combined ²²⁶ Ra and ²²⁸ Ra	8-18
8.2.3.3	Gross Alpha Particle Activity Including ²²⁶ Ra But Excluding Radon and Uranium.....	8-19
8.2.3.4	Annual Dose Equivalent to the Total Body or Any Internal Organ from the Average Annual Concentration of Beta Particle and Photon Radioactivity from Man-Made Radionuclides	8-20
8.3	Compliance Summary.....	8-20
REFERENCES	.....	8-21
9.0.	<i>PEER-2004 REVIEW</i>	9-1
9.1	<i>Regulatory Requirements</i>	9-3
9.2	<i>Peer Review Process</i>	9-4
9.2.1	<i>Peer Review Plan</i>	9-5
9.2.2	<i>Size and Composition of Peer Review Panels</i>	9-5
9.2.3	<i>Technical Qualifications of Panel Members</i>	9-6
9.2.4	<i>Independence of Panel Members</i>	9-7
9.2.5	<i>Training of Peer Review Panel Members</i>	9-7
9.2.6	<i>Peer Review Panel Report</i>	9-7
9.2.7	<i>Quality Assurance Records Management</i>	9-8
9.2.8	<i>Quality Assurance Oversight</i>	9-8
9.3	<i>Peer Reviews Conducted After Promulgation of 40 CFR Part 194</i>	9-8
9.3.1	<i>Conceptual Models Peer Review</i>	9-9
9.3.1.1	<i>Adequate Models</i>	9-13
9.3.1.2	<i>Inadequate Models</i>	9-16
9.3.1.3	<i>Post-CCA Conceptual Models Peer Review</i>	9-23
9.3.2	<i>Waste Characterization Analysis Peer Review</i>	9-39
9.3.2.1	<i>General Results</i>	9-40
9.3.2.2	<i>Waste Characterization Peer Review Panel Concerns</i>	9-41
9.3.3	<i>Engineered Alternatives Cost/Benefit Study Peer Review</i>	9-44
9.3.3.1	<i>General Results</i>	9-46
9.3.3.2	<i>Engineered Alternatives Cost/Benefit Study Peer Review Panel Concerns</i>	9-46
9.3.4	<i>Engineered Systems Data Qualification Peer Review</i>	9-55
9.3.5	<i>Natural Barriers Data Qualification Peer Review</i>	9-58
9.3.6	<i>Waste Form and Disposal Room Data Qualification Peer Review</i>	9-61
9.3.7	<i>Passive Institutional Controls Peer Review</i>	9-62
9.4	<i>Peer Reviews Conducted in Addition to Those Required by 40 CFR Part 194.27(a)</i>	9-64

9.4.1	<i>NAS WIPP Panel Reviews</i>	9-67
9.4.1.1	<i>Letter Report of May 1, 1979</i>	9-68
9.4.1.2	<i>Letter Report of September 10, 1979</i>	9-68
9.4.1.3	<i>Continuing Evaluation of the Carlsbad Site</i>	9-68
9.4.1.4	<i>Review of the Criteria for the Site Suitability, Design, Construction, and Operation of the Proposed Waste Isolation Pilot Plant (WIPP); Progress Report: July 1, 1978, to December 31, 1979</i>	9-68
9.4.1.5	<i>Review of the Criteria for the Site Suitability, Design, Construction, and Operation of the Proposed Waste Isolation Pilot Plant (WIPP); Interim Report: July 1, 1978, to July 31, 1982</i>	9-68
9.4.1.6	<i>Review of the Scientific and Technical Criteria for the Waste Isolation Pilot Plant (WIPP)</i>	9-69
9.4.1.7	<i>Letter Report of April 1987 on Planned Sorbing-Tracer Field Tests</i>	9-69
9.4.1.8	<i>Report of March 3, 1988 on Brine Accumulation in the WIPP Facility</i>	9-69
9.4.1.9	<i>Letter Report of December 1988 on Experiments of Room Closure Rates</i>	9-70
9.4.1.10	<i>Review Comments on DOE Document DOE/WIPP 89-011: Draft Plan for the Waste Isolation Pilot Plant Test Phase: Performance Assessment and Operations Demonstration</i>	9-70
9.4.1.11	<i>Letter Report of April 1991, Summary of Recommendations</i>	9-70
9.4.1.12	<i>Letter Report of June 1992</i>	9-70
9.4.1.13	<i>The Waste Isolation Pilot Plant: A Potential Solution for the Disposal of Transuranic Waste (NAS 1996)</i>	9-70
9.4.1.14	<i>Improving Operations and Long-Term Safety of the Waste Isolation Pilot Plant – Final Report (April 2001)</i>	9-76
9.4.1.15	<i>Characterization of Remote-Handled Transuranic Waste for the Waste Isolation Pilot Plant – Final Report (2002)</i>	9-80
9.4.2	<i>Performance Assessment Peer Review Panel</i>	9-82
9.4.3	<i>Shaft Seal Design Independent Review</i>	9-84
9.4.4	<i>Engineered Alternatives Task Force Report Peer Review</i>	9-87
9.4.4.1	<i>Quality of Technical Work</i>	9-88
9.4.4.2	<i>Utility of a Single Figure-of-Merit</i>	9-89
9.4.4.3	<i>Use of Relative versus Absolute Risk</i>	9-89
9.4.5	<i>Blue Ribbon Panel Peer Review</i>	9-90
9.4.6	<i>Advisory Committee on Nuclear Facility Safety Review</i>	9-93
9.4.7	<i>Performance Assessment Review Team</i>	9-96

9.4.8	<i>INTRAVAL</i>	9-97
9.4.9	<i>Waste Isolation Pilot Plant Conceptual Model Uncertainty Group Review</i>	9-99
9.4.10	<i>Environmental Evaluation Group Reviews</i>	9-101
9.4.10.1	<i>EEG-2 (1978): Review Comments on the GCR, Waste Isolation Pilot Plant (WIPP) Site, Southeastern New Mexico, SAND78-1596, Volumes I and II</i>	9-104
9.4.10.2	<i>EEG-3 (1979): Radiological Health Review of the Draft Environmental Impact Statement (DOE/EIS-0026-D) Waste Isolation Pilot Plant, U.S. Department of Energy</i>	9-104
9.4.10.3	<i>EEG-8 (1980): The Significance of Certain Rustler Aquifer Parameters for Predicting Long-Term Radiation Doses from WIPP</i>	9-104
9.4.10.4	<i>EEG-9 (1981): An Approach to Calculating Upper Bounds on Maximum Individual Doses from the Use of Contaminated Well Water Following a WIPP Repository Breach</i>	9-104
9.4.10.5	<i>EEG-10 (1981): Radiological Health Review of the Final Environmental Impact Statement, (DOE/EIS-0026), Waste Isolation Pilot Plant, U.S. Department of Energy</i>	9-104
9.4.10.6	<i>EEG-11 (1982): Calculated Radiation Doses from Radionuclides Brought to the Surface If Future Drilling Intercepts the WIPP Repository and Pressurized Brine</i>	9-104
9.4.10.7	<i>EEG-12 (1982): Potential Release Scenario and Radiological Consequence Evaluation of Mineral Resources at WIPP</i>	9-104
9.4.10.8	<i>EEG-22 (1983): EEG Review Comments on the Geotechnical Reports Provided by DOE to EEG Under the Stipulated Agreement Through March 1, 1983; and EEG-23 (1983): Evaluation of the Suitability of the WIPP Site</i>	9-104
9.4.10.9	<i>EEG-29 (1985): Evaluation of the Safety Analysis Report for the Waste Isolation Pilot Plant Project</i>	9-104
9.4.10.10	<i>EEG-40 (1989): Review of the Final Safety Analysis Report (Draft), DOE Waste Isolation Pilot Plant</i>	9-105
9.4.10.11	<i>EEG-41 (1989): Review of the Draft SEIS, DOE Waste Isolation Pilot Plant, April 1989</i>	9-105
9.4.10.12	<i>EEG-50 (1992): Implications of Oil and Gas Leases at the WIPP on Compliance with EPA TRU Waste Disposal Standards</i>	9-105

9.4.10.13	<i>EEG-57 (1994): An Appraisal of the 1992 Preliminary Performance Assessment for the Waste Isolation Pilot Plant</i>	9-105
9.4.10.14	<i>EEG-61 (1996): Review of the WIPP Draft Application to Show Compliance with EPA TRU Waste Disposal Standards</i>	9-105
9.4.10.15	<i>EEG-62 (1996): Fluid Injection for Salt Water Disposal and Enhanced Oil Recovery as a Potential Problem for the WIPP: Proceedings of a June 1995 Workshop and Analysis, by Matthew K. Silva (Silva 1996)</i>	9-105
9.4.10.16	<i>EEG-64 (1997): Review of the Draft Supplement to the WIPP Environmental Impact Statement DOE/EIS-0026-S-2, by Robert H. Neill, James K. Channell, Peter Spiegler, and Lokesh Chaturvedi (Neill et al. 1997)</i>	9-106
9.4.10.17	<i>EEG-66 (1998): Individual Radiation Doses from Transuranic Waste Brought to the Surface by Human Intrusion at the WIPP by James K. Channell and Robert H. Neill (Channell and Neill 1998)</i>	9-106
9.4.10.18	<i>EEG-68 (1998): Evaluation of the WIPP Project's Compliance with the EPA Radiation Protection Standards for Disposal of Transuranic Waste by Robert H. Neill, Lokesh Chaturvedi, Dale F. Rucker, Matthew K. Silva, Ben A. Walker, James K. Channell, and Thomas M. Clemo (Neill et al. 1998)</i>	9-108
9.4.10.19	<i>EEG-69 (1998): Sensitivity Analysis of Performance Parameters Used in Modeling the WIPP by Dale F. Rucker (Rucker 1998)</i>	9-112
9.4.10.20	<i>EEG-75 (1999): Evaluation of Risk and Waste Characterization Requirements for the Transuranic Waste Emplaced in WIPP during 1999 by James C. Channell and Ben A. Walker (Channell and Walker 2000)</i>	9-114
9.4.10.21	<i>EEG-77 (2000): Plutonium Chemistry Under Conditions Relevant for WIPP Performance Assessment: Review of Experimental Results and Recommendations for Future Work by Virginia Oversby (Oversby 2000)</i>	9-116
9.4.10.22	<i>EEG-82 (2001): Evaluation of Proposed Panel Closure Modifications at WIPP by Lawrence E. Allen, Matthew K. Silva, James K. Channell, John F. Abel, and Dudley R. Morgan (Allen et al. 2001)</i>	9-117
9.4.10.23	<i>EEG-83 (2002): Identification of Issues Relevant to the First Recertification of WIPP by Lawrence E.</i>	

	<i>Allen, Matthew K. Silva, James K. Channell (Allen et al. 2002)</i>	9-117
9.4.10.24	<i>EEG-85 (2003): Analysis of Emplaced Waste Data and Implications of Non-Random Emplacement for Performance Assessment for the WIPP by Lawrence E. Allen and James K. Channell (Allen and Channell 2003)</i>	9-119
9.4.10.25	<i>EEG-86 (2003): Contact Handled Transuranic Waste Characterization Requirements at the Waste Isolation Pilot Plant by Matthew K. Silva, James C. Channell, Ben A. Walker, and George Anastas (Silva et al. 2003)</i>	9-120
9.4.11	<i>Fracture Expert Group Review</i>	9-123
9.4.12	<i>Fanghänel Review – WIPP Thermodynamic Model for Trivalent Actinides</i>	9-125
9.4.13	<i>Independent Technical Review of the Bin and Alcove Test Programs</i>	9-127
9.4.14	<i>Performance Assessment Reviews</i>	9-130
9.4.14.1	<i>1990 Performance Assessment Report</i>	9-131
9.4.14.2	<i>1991 Performance Assessment Report</i>	9-132
9.4.14.3	<i>1992 Performance Assessment Report</i>	9-132
9.4.14.4	<i>Department of Energy Response to Comments on the 1990, 1991, and 1992 Performance Assessment Reports</i>	9-134
9.4.15	<i>Technical Support Group Reviews</i>	9-134
9.4.15.1	<i>Review of Experimental Plan for Tracer Testing in the Culebra Dolomite</i>	9-136
9.4.15.2	<i>Performance Assessment Parameters</i>	9-136
9.4.16	<i>NEPA Reviews</i>	9-137
9.4.17	<i>International Peer Review by the Nuclear Energy Authority/ International Atomic Energy Agency International Review Group, 1996-97 (NEA/IAEA 1997)</i>	9-139
9.4.17.1	<i>Objective of the Review</i>	9-141
9.4.17.2	<i>Scope</i>	9-141
9.4.17.3	<i>Conclusions</i>	9-142
9.4.18	<i>GEOTRAP</i>	9-146
9.4.19	<i>Institute for Regulatory Science Reviews</i>	9-147
9.4.19.1	<i>Requirements for Disposal of Remote-Handled Transuranic Waste at the Waste Isolation Pilot Plant (2002) (RSI 2002)</i>	9-147
9.4.19.2	<i>Desirability of Performing Certain Transuranic Waste Characterization Tests (RSI 2003)</i>	9-149
REFERENCES	.....	9-152
APPENDIX AUD-2004	.....	1
APPENDIX BARRIERS	.....	1

APPENDIX DATA-2004 1

Attachment A: Delaware Basin Drilling Surveillance Data1

Attachment B: Historical Water Level Data1

Attachment C: Water Quality Sampling Data1

Attachment D: Inventory and Emplaced Waste Data.....1

Attachment E: WWIS Nuclide Report.....1

Attachment F: TRU Waste Inventory Update Report1

Annex A. Method For Correction And Completion Of Data From The Sites ... 1

Annex B. Comparison of 2003 Update Data to TWBIR Revision 3 1

Annex C. Crosswalk of TWBIR Revision 2 and 2003 Update Waste Streams... 1

Annex D. Packaging Materials 1

Annex E. Waste Stream Level Radionuclide Activities for the
 CRA-2004 1

Annex F. Non-WIPP Screening Criteria Memo 1

Annex G. Data Requirements..... 1

Annex H. Clarification of Data Requirements 1

Annex I. Waste Stream Profiles—Non-WIPP 1

Annex J. Waste Stream Profiles—WIPP 1

Annex K. Waste Stream Profiles—Emplaced 1

Attachment G: WIPP Borehole Update1

Attachment H: WIPP Waste Containers and Emplacement.....1

APPENDIX MON-2004..... 1

Attachment A: Postclosure Monitoring 1

APPENDIX PA 1

Attachment MASS.....1

Attachment PAR.....1

Attachment PORSURF1

Attachment SCR.....1

Attachment TFIELD1

APPENDIX PEER-2004..... 1

APPENDIX QAPD..... 1

APPENDIX TRU WASTE..... 1

List of Figures

Figure 1-1. Final WIPP CCDF 1-7

Figure 1-2. WIPP Location in Southeastern New Mexico 1-12

Figure 1-3. Methodology for Performance Assessment of the WIPP 1-14

Figure 2-1. WIPP Site Location in Southeastern New Mexico 2-3

Figure 2-2. WIPP Site and Vicinity Borehole Location Map (partial)..... 2-15

Figure 2-3.	<i>Locations of Culebra Monitoring Wells Inside the WIPP Site Boundary</i>	2-16
Figure 2-4.	<i>Locations of Culebra Monitoring Wells Located Outside the WIPP Site Boundary</i>	2-16
Figure 2-5.	<i>Locations of Magenta Monitoring Wells</i>	2-17
Figure 2-6.	<i>Locations of Monitoring Wells Completed to Hydrostratigraphic Units Other Than the Culebra and Magenta Dolomite Members (See also Figure 2-39).</i>	2-18
Figure 2-37.	Major Geologic Events - Southeast New Mexico Region	2-19
Figure 2-8.	<i>Partial Site Geologic Column</i>	2-20
Figure 2-59.	Schematic Cross-Section from Delaware Basin (southeast) through Marginal Reef Rocks to Back-Reef Facies (based on King, P.B., 1948)	2-23
Figure 2-610.	Structure Contour Map of Top of Bell Canyon	2-25
Figure 2-711.	Generalized Stratigraphic Cross Section above Bell Canyon Formation at WIPP Site	2-26
Figure 2-812.	Salado Stratigraphy in the Vicinity of the WIPP Disposal Zone	2-30
Figure 2-13.	<i>Dissolution Margin for the Upper Salado</i>	2-34
Figure 2-9.	Rustler Stratigraphy (From Appendix FAC, Figure 3.2)	2-37
Figure 2-14.	<i>Rustler Stratigraphy</i>	2-38
Figure 2-10.	Halite Margins in the Rustler	2-40
Figure 2-15.	<i>Halite Margins for the Rustler Formation Members</i>	2-41
Figure 2-116.	Isopach Map of the Entire Rustler	2-43
Figure 2-1217.	Percentage of Natural Fractures in the Culebra Filled with Gypsum	2-46
Figure 2-1318.	Log Character of the Rustler Emphasizing Mudstone-Halite Lateral Relationships	2-49
Figure 2-1419.	Isopach of the Dewey Lake	2-52
Figure 2-1520.	Isopach of the Santa Rosa	2-54
Figure 2-1621.	Isopach of the Gatuña	2-56
Figure 2-1722.	Physiographic Provinces and Sections	2-60
Figure 2-2325.	Topographic Map of the Area Around the WIPP Site	2-61
Figure 2-18.	Topographic Map of the Area Around the WIPP Site	2-62
Figure 2-1924.	Structural Provinces of the Permian Basin Region	2-64
Figure 2-2025.	Loading and Unloading History Estimated to the Base of the Culebra	2-67
Figure 2-2126.	Regional Structures	2-70
Figure 2-2227.	Igneous Dike in the Vicinity of the WIPP Site	2-72
Figure 2-28.	<i>Elevations of the Top of the Culebra Dolomite Member</i>	2-75
Figure 2-2329.	Isopach from the Base of MB 103 to the Top of the Salado	2-79
Figure 2-24.	Structure Contour Map of Culebra Dolomite Base	2-82
Figure 2-25.	Drainage Pattern in the Vicinity of the WIPP Facility	2-84
Figure 2-2630.	Schematic West-East Cross Section through the North Delaware Basin	2-86
Figure 2-2731.	Schematic North-South Cross Section through the North Delaware Basin	2-87
Figure 2-2832.	Recent Occurrences of Pressurized Brine in the Castile	2-94
Figure 2-2933.	Outline of the Groundwater Basin Model Domain on a Topographic Map	2-100
Figure 2-3034.	Transmissivities of the Culebra	2-106

Figure 2-35.	<i>Correlation Between Culebra Transmissivity (log T (m²/s)) and Overburden Thickness for Different Geologic Environments (after Holt and Yarbrough 2002)</i>	2-108
Figure 2-36.	<i>Water-level Trends in Nash Draw Wells and at P-14 (see Figure 2-2 for well locations)</i>	2-111
Figure 2-31.	Hydraulic Heads in the Culebra	2-113
Figure 2-37.	<i>Hydraulic Heads in the Culebra</i>	2-114
Figure 2-32 38.	Hydraulic Heads in the Magenta (1980s)	2-118
Figure 2-33.	Interpreted Water Table Surface	2-122
Figure 2-39.	<i>Site Map of WIPP Surface Structures Area Showing Location of Wells (e.g., C-2505) and Piezometers (e.g., PZ-1) (after INTERA 1997)</i>	2-124
Figure 2-40.	<i>Santa Rosa Potentiometric Surface Map</i>	2-125
Figure 2-34 41.	Brine Aquifer in the Nash Draw (Redrawn from CCA Appendix HYDRO, Figure 14)	2-127
Figure 2-35.	Measured Water Levels of the Unnamed Lower Member and Rustler-Salado Contact Zone	2-129
Figure 2-42.	<i>Measured Water Levels of the Los Medaños and Rustler-Salado Contact Zone (1980s)</i>	2-130
Figure 2-36 43.	Location of Reservoirs and Gauging Stations in the Pecos River Drainage Area	2-132
Figure 2-37 44.	Known Potash Leases Within the Delaware Basin	2-137
Figure 2-38 45.	Extent of Economically Mineable Reserves Inside the Site Boundary (Based on NMBMMR Report)	2-138
Figure 2-39 46.	Delaware Basin Boundary	2-141
Figure 2-47.	<i>Distribution of Existing Petroleum Industry Boreholes Within Two Miles of the WIPP Site</i>	2-142
Figure 2-40.	Hydrochemical Zones of the Culebra	2-153
Figure 2-41.	Monthly Precipitation for the WIPP Site from 1990 through 1994	2-165
Figure 2-48.	<i>Monthly Precipitation for the WIPP Site from 1990-2002</i>	2-166
Figure 2-42.	1991 Annual Windrose WIPP Site	2-167
Figure 2-43.	1992 Annual Windrose WIPP Site	2-168
Figure 2-44.	1993 Annual Windrose WIPP Site	2-169
Figure 2-45.	1994 Annual Windrose WIPP Site	2-170
Figure 2-49.	<i>1995 Annual Wind Rose at 10-m (33-ft.) Height at WIPP Site</i>	2-171
Figure 2-50.	<i>1996 Annual Wind Rose at 10-m (33-ft.) Height at WIPP Site</i>	2-172
Figure 2-51.	<i>1997 Annual Wind Rose at 10-m (33-ft.) Height at WIPP Site</i>	2-173
Figure 2-52.	<i>1998 Annual Wind Rose at 10-m (33-ft.) Height at WIPP Site</i>	2-174
Figure 2-53.	<i>1999 Annual Wind Rose at 10-m (33-ft.) Height at WIPP Site</i>	2-175
Figure 2-54.	<i>2000 Annual Wind Rose at 10-m (33-ft.) Height at WIPP Site</i>	2-176
Figure 2-55.	<i>2001 Annual Wind Rose at 10-m (33-ft.) Height at WIPP Site</i>	2-177
Figure 2-56.	<i>2002 Annual Wind Rose at 10-m (33-ft.) Height at WIPP Site</i>	2-178
Figure 2-46.	1994 Annual Wind Rose Carlsbad, NM	2-179
Figure 2-47 57.	Regional Earthquake Epicenters Occurring between 1961 and 2002	2-181
Figure 2-48 58.	Seismic Source Zones	2-184
Figure 2-49 59.	Alternate Source Geometries	2-185

Figure 2-5060.	Total WIPP Facility Risk Curve Extrema.....	2-187
Figure 3-1.	WIPP Property Sector Designators.....	3-2
Figure 3-2.	Plan View of WIPP Underground Facility and Panel Closure Systems.....	3-4
Figure 3-3.	Typical Panel Waste Emplacement	3-5
Figure 3-4.	Panel 1 Waste Emplacement	3-6
Figure 3-33-5.	Spatial View of the WIPP Facility.....	3-8
Figure 3-6.	Room Cross-Section Showing the Position of Supersacks	3-15
Figure 3-43-7.	Proposed Seal Design for the WIPP AIS.....	3-19
Figure 3-53-8.	Panel Closure	3-28
Figure 3-63-9.	Location of Panel Closure System	3-29
Figure 3 7.	Backfill Sacks Used with Seven Pack and Standard Waste Box.....	3-31
Figure 3 8.	Room Cross Section Showing the Position of Backfill Sacks.....	3-32
Figure 3-93-10.	Approximate Locations of Unplugged Boreholes	3-33
Figure 3 10.	Typical Deep Borehole Plugged to Requirements of Order R-111-P.....	3-36
Figure 4 1.	Waste Description Information Flow.....	4-4
Figure 4-1.	Waste Description Information Flow	4-5
Figure 4 2.	U.S. DOE TRU Waste Generator and Storage Sites.....	4-8
Figure 4 3.	Schematic of Waste Stream Profile Methodology.....	4-22
Figure 4 4.	Origins of the WAC.....	4-41
Figure 4-25.	WIPP Waste Information System Process and Data Flow.....	4-44
Figure 4 6.	QA Document Hierarchy for Waste Characterization.....	4-47
Figure 4-3.	QA Documents Hierarchy	4-48
Figure 4 7.	Requirements Hierarchy of TRU Waste Characterization for Transportation and Disposal.....	4-51
Figure 4-4.	Program QA Document Hierarchy	4-52
Figure 5-1.	Requirements Flow-Down Chart	5-3
Figure 5-2.	Reporting Interface Diagram	5-4
Figure 6-1.	Summary CCDFs for Replicates 1, 2, and 3	6-4
Figure 6-16-2.	Methodology for performance assessmentPA of the WIPP.....	6-18
Figure 6-26-3.	Estimated CCDF For Consequence Results.....	6-21
Figure 6-36-4.	Example Distribution of a Family of CCDFs Obtained by Sampling Imprecisely Known Variables.....	6-23
Figure 6-46-5.	Example Summary Curves Derived from an Estimated Distribution of CCDFs.....	6-24
Figure 6-56-6.	Distribution Function for an Imprecisely Known Variable.....	6-30
Figure 6-66-7.	Screening Process Based on Screening Classifications.....	6-36
Figure 6-76-8.	Logic Diagram for Scenario Analysis.....	6-57
Figure 6-86-9.	Conceptual Release Pathways for the Undisturbed Performance Scenario.....	6-64
Figure 6-96-10.	Conceptual Release Pathways for the Disturbed Performance Mining Scenario.....	6-67

Figure 6-10	6-11.	Conceptual Release Pathways for the Disturbed Performance Deep Drilling E2 Scenario	6-69
Figure 6-11	6-12.	Conceptual Release Pathways for the Disturbed Performance Deep Drilling Scenario E1	6-70
Figure 6-12	6-13.	Conceptual Release Pathways for the Disturbed Performance Deep Drilling Scenario E1E2	6-71
Figure 6-13	6-14.	A Side View of the BRAGFLO Elements and Material Regions Used for Simulation of Undisturbed Performance.....	6-76
Figure 6-14	6-15.	A Side View of the BRAGFLO Elements and Material Regions Used to Simulate the E1 Event.....	6-77
Figure 6-15	6-16.	A Side View of the BRAGFLO CRA-2004 Geometry Drawn to Scale.....	6-78
Figure 6-16		A Top Down View of a row of Elements in BRAGFLO Used for Undisturbed Performance	6-78
Figure 6-17.		<i>The MODFLOW-2000 Domain Used in the Groundwater Model of the Culebra</i>	6-112
Figure 6-18.		<i>Extent of SECOTP2D Domain with Respect to the MODFLOW-2000 Culebra Domain and WIPP Site Boundary</i> The Discretization Used in Modeling Groundwater Flow in the Culebra	6-113
Figure 6-17.		The Regional and Local Domains Used in the Horizontal Groundwater Model of the Culebra	6-116
Figure 6-19.		Extent of Mining in the McNutt in Undisturbed Performance within MODFLOW-2000 SECOTP2D Regional Model Domain.....	6-122
Figure 6-19.		Extent of Future Mining in the McNutt the Controlled Area Considered in Disturbed Performance	6-124
Figure 6-20.		Extent of Future Mining in the McNutt within the Controlled Area Considered in Disturbed Performance	6-125
Figure 6-21.		Extent of Impacted Area in the Culebra from Mining In the McNutt Outside the Controlled Area for Undisturbed Performance	6-126
Figure 6-22.		Extent of Impacted Area in the Culebra for Disturbed Performance if Mining In the McNutt Occurs in the Future Within the Controlled Area .	6-127
Figure 6-20.		<i>Extent of Impacted Area in the Culebra from Mining in the McNutt Potash Zone of the Salado Outside the Controlled Area for Undisturbed Performance</i>	6-128
Figure 6-21.		<i>Extent of Impacted Area in the Culebra for Disturbed Performance if Mining in the McNutt Potash Zone of the Salado Occurs in the Future Within and Outside of the Controlled Area</i>	6-129
Figure 6-22	6-23.	Schematic Representation of a Rotary Drilling Operation Penetrating the Repository	6-134
Figure 6-23	6-24.	Repository-Scale Horizontal BRAGFLO Mesh Used for Direct Brine Release Calculations	6-137
Figure 6-24	6-25.	Major Codes, Code Linkages, and Flow of Numerical Information in WIPP Performance Assessment PA.....	6-156
Figure 6-25	6-26.	Schematic Side View of the Disposal System Associating Performance Assessment PA Codes with the Components of the Disposal System Each Code Simulates	6-158

Figure 6-26 27.	Probability of Intrusions in 10,000 Years with Active Institutional Control	6-159
Figure 6-27 28.	Discretized Locations for Random Intrusion by an Exploratory Borehole.....	6-165
Figure 6-28 29.	Levels of Information Available in the TWBID.....	6-166
Figure 6-29 30.	Flowchart Showing Integration of TWBID Data in performance assessmentPA Calculations.....	6-167
Figure 6-30 31.	Cumulative Distribution Function for Waste Stream EPA Units/Volume.....	6-168
Figure 6-32 31.	Code Configuration for the Undisturbed Performance UP Scenario.....	6-173
Figure 6-33 32.	Code Configuration for Disturbed Performance DP Scenarios E1 and E2	6-175
Figure 6-34 33.	Code Configuration for Disturbed Performance DP Scenario E1E2.....	6-176
Figure 6-34 35.	Distribution of CCDFs for Normalized Radionuclide Releases to the Accessible Environment from the WIPP, Replicate 1.....	6-184
Figure 6-35 36.	Distribution of CCDFs for Normalized Radionuclide Releases to the Accessible Environment from the WIPP, Replicate 2.....	6-185
Figure 6-36 37.	Distribution of CCDFs for Normalized Radionuclide Releases to the Accessible Environment from the WIPP, Replicate 3.....	6-186
Figure 6-37 38.	Mean CCDFs for Normalized Radionuclide Releases to the Accessible Environment.....	6-187
Figure 6-38 39.	Confidence Levels for the Mean CCDF	6-188
Figure 6-40 40.	Summary CCDFs for Replicates 1, 2, and 3.....	6-189
Figure 6-39 41.	Mean CCDFs for Specific Release Modes, Replicate 1	6-190
Figure 7-1.	Implementation Timeline.....	7-2
Figure 7-1.	Implementation Timeline -- Assurance Requirements	7-3
Figure 7-2.	Grazing Allotments on the WIPP Site as of October 1996 September 2002	7-11
Figure 7-3.	Area Where Hunting is Permitted Within the WIPP Site Boundary	7-12
Figure 7-4.	Locations of Rights-of-Way Within the WIPP Site Boundary as of October 1996 September 2002	7-14
Figure 7-5.	Locations of Groundwater Wells Within the WIPP Site Boundary as of October 1996	7-15
Figure 7-5.	Locations of Water Quality Sampling Wells	7-16
Figure 7-6.	Location of Surface Quarries Within the WIPP Site Boundary as of October 1996 September 2002	7-17
Figure 7-7.	Location of Potash Exploration Holes and Economically Minable Potash Within the WIPP Site Boundary as of September 2002	7-19
Figure 7-8.	Hydrocarbon Holes Located Within the WIPP Site Boundary as of September 2002	7-20
Figure 7-9.	Planned Repository Footprint	7-23
Figure 7-10.	Layout and Instrumentation of Geomechanical Monitoring System as of January 1996	7-47
Figure 7- 10 13.	Repository Footprint Perimeter Monument Configuration.....	7-61
Figure 7- 11 14.	Controlled Area Perimeter Monument Configuration	7-62
Figure 7- 12 15.	Small Buried Warning Marker.....	7-63

Figure 7-13~~16~~. Berm Construction 7-64
 Figure 7-12. ~~Passive Institutional Controls Timeline~~ 7-71
Figure 7-14. *Passive Institutional Controls - Long Term Schedule* 7-72
 Figure 8-1. Conceptual Transport Pathway 8-6

List of Tables

Table 1-1. *Description of CRA-2004 Content Compared to the CCA* 1-19
~~Table 2-1. Issues Related to the Natural Environment That Were Evaluated for the WIPP Performance Assessment Scenario Screening~~ 2-4
Table 2-1. *Issues Related to the Natural Environment That Were Evaluated for the WIPP PA Scenario Screening* 2-7
 Table 2-2. Chemical Formulas, Distributions, and Relative Abundances of Minerals in the Castile, Salado, and Rustler Formations 2-31
 Table 2-3. Culebra Thickness Data Sets 2-47
 Table 2-4. Hydrologic Characteristics of the Rustler at the WIPP and in Nash Draw 2-88
Table 2-5. *Depth Intervals of the Injection Zones of Six Salt-Water Injection Wells Located Near Well H-9 (after SNL 2003a)* 2-93
~~Table 2-56. WIPP Salado and Castile Brine Compositions~~ 2-96
Table 2-7. *Estimates of Culebra Transmissivity Model Coefficients* 2-108
Table 2-8. *Ninety-Five Percent Confidence Intervals for Culebra Water-Quality Baseline* 2-110
Table 2-9. *Ninety-Five Percent Confidence Intervals for Dewey Lake Water-Quality Baseline* 2-120
~~Table 2-6~~**10. Capacities of Reservoirs in the Pecos River Drainage** 2-133
~~Table 2-7~~**11. Current Estimates of Potash Resources at the WIPP Site** 2-136
~~Table 2-8~~**12. In-Place Oil within Study Area** 2-139
~~Table 2-9~~**13. In-Place Gas within Study Area** 2-139
~~Table 2-10. Ranges of Mean Values Measured for Radioactive Isotopes In Soils at WIPP Site, 5 Miles from WIPP, and beyond 5 Miles from WIPP~~ 2-157
~~Table 2-11. Mean Values Measured for Radionuclides in Water Wells around the WIPP Site~~ 2-159
~~Table 2-12. Annual Average, Maximum, and Minimum Temperatures~~ 2-163
Table 2-14. *Annual Average, Maximum, and Minimum Temperatures* 2-164
 Table 3-1. WIPP Site Features 3-7
~~Table 3-12. Governing Regulations for Borehole Abandonment~~ 3-35
Table 4-1. *Emplaced, Stored, and Projected CH-TRU Waste Inventory as of September 30, 2002* 4-9
Table 4-2. *Stored and Projected RH-TRU Waste Inventory as of September 30, 2002* 4-10
Table 4-3. *Approved TRU Waste Site Quality Assurance and Waste Characterization Programs as of September 30, 2002* 4-10

Table 4-1.	Waste Characteristics and Components That are Expected to Have Significant and Negligible Effects	4-15
Table 4-2.	WMCs and Their Anticipated Final Waste Form	4-17
Table 4-3.	Anticipated Nonradionuclide TRU Waste Inventory for the WIPP	4-23
Table 4-4.	Nonradionuclide TRU Waste Inventory for the WIPP	4-24
Table 4-4.	WIPP CH TRU WMP Disposal Inventory	4-26
Table 4-5.	WIPP CH-TRU Waste and Container Material Disposal Inventory	4-27
Table 4-5.	WIPP RH TRU WMP Disposal Inventory	4-27
Table 4-6.	WIPP RH-TRU Waste and Container Material Disposal Inventory	4-28
Table 4-6.	Important Radionuclides Considered in Performance Assessment	4-30
Table 4-7.	Radionuclides Considered in PA	4-31
Table 4-8.	Waste Characteristics and Components Expected to be Most Significant to Performance	4-34
Table 4-8.	Radionuclides That Contribute to the Waste Unit Factor	4-35
Table 4-9.	Radionuclides That Contribute to the Waste Unit Factor	4-36
Table 4-10.	Waste Characteristics and Components Expected to be Insignificant	4-36
Table 4-11.	Repository-Based Emplacement Limits Related to Performance Assessment PA	4-37
Table 4-12.	Repository-Based Emplacement Limits Imposed by the LWA	4-39
Table 4-13.	Quantities of Radionuclides Emplaced in the Repository as of September 30, 2002	4-39
Table 4-14.	Quantities of Non-Radionuclide Waste Components Emplaced in the Repository as of September 30, 2002, and Associated Emplacement Limits	4-40
Table 4-12.	Container Based Limits Imposed by the WAC	4-40
Table 4-15.	Container-Based Limits	4-40
Table 4-16.	Applicable CH- and RH-TRU Waste Component Characterization methods	4-55
Table 5-1.	QAPD vs. NQA-1, -2, and -3 Requirements	5-24
Table 6-1.	WIPP Project Changes and Cross References	6-2
Table 6-2.	Release Limits for the Containment Requirements	6-17
Table 6-3.	FEP Identification Studies Used in the SKI Study	6-33
Table 6-4.	Natural FEPs and Their Screening Classifications	6-38
Table 6-5.	Waste- and Repository-Induced FEPs and Their Screening Classifications	6-41
Table 6-6.	Human-Initiated EPs and Their Screening Classifications	6-47
Table 6-7.	FEPs Reassessment Summary Results	6-56
Table 6-8.	Undisturbed Performance FEPs	6-60
Table 6-9.	Disturbed Performance FEPs	6-65
Table 6-10.	Repositoryal and Panel Closures Parameter Values	6-84
Table 6-11.	BRAGFLO Fluid Properties	6-85
Table 6-12.	Average-Stoichiometry Gas Generation Model Parameter Values	6-86
Table 6-11.	Summary of Dissolved Actinide Solubilities (moles per liter) in Castile and Salado Brines	6-93

Table 6-13.	<i>Actinide Solubilities (M) Calculated (+III, +IV, and +V) or Estimated (+VI) for the CRA-2004 PA, the 1997 PAVT, and the CCA</i>	6-95
Table 6-14 12.	Colloid Concentration Factors	6-98
Table 6-15 13.	Shaft Materials Parameter Values.....	6-100
Table 6-16 14.	Salado Impure Halite Parameter Values	6-102
Table 6-17 15.	Parameter Values for Salado Anhydrite Interbeds a and b, and MB138 and MB139.....	6-104
Table 6-18 16.	Fracture Parameter Values for Salado Anhydrite Interbeds a and b, and MB138 and MB139	6-104
Table 6-19 17.	DRZ Parameter Values	6-105
Table 6-20 18.	Culebra Parameter Values for the BRAGFLO Model.....	6-114
Table 6-21 19.	SECO-MODFLOW-2000 Fluid Properties	6-115
Table 6-22 20.	Matrix Distribution Coefficients (Kds) and Molecular Diffusion Coefficients for Dissolved Actinides in the Culebra	6-119
Table 6-23 21.	Culebra Actinides Flow and Transport Parameters Required for SECOTP2D SECO Codes	6-119
Table 6-24 22.	Model Parameter Values for the Magenta	6-131
Table 6-25 23.	Dewey Lake Parameters for the BRAGFLO Model.....	6-132
Table 6-26 24.	Supra-Dewey Lake Unit Parameters for the BRAGFLO Model.....	6-133
Table 6-27 25.	Intrusion Borehole Properties for the BRAGFLO and CUTTINGS_S Models.....	6-139
Table 6-28 26.	Parameter Values Used for Brine Reservoirs in the BRAGFLO Calculations.....	6-142
Table 6-29 27.	Climate Change Properties for the SECOTP2D SECOFL2D Model.....	6-147
Table 6-30 28.	Probabilities of Different Numbers of Intrusions into the Waste Disposal Region (for 100 years of active institutional control, 600 years of passive institutional control , and 9,930 years of uncontrolled activity)	6-164
Table 6-31 29.	Changes in BRAGFLO Borehole Properties in Developing Reference Behavior for the E1E2 Scenario	6-178
Table 6-32 30.	Conservative Model and Parameter Assumptions Used in Performance Assessment PA	6-193
Table 7-1.	Effectiveness of Active Controls Activities.....	7-8
Table 7-1.	<i>Effectiveness of Active Controls Activities</i>	7-9
Table 7-2.	Potentially Significant Disposal System Parameters	7-31
Table 7-3.	Disposal System Parameters Determined to be of Highest Significance to Disposal System Performance	7-35
Table 7-4.	<i>Parameters Related to Measurable Disposal System Properties</i>	7-37
Table 7-5.	Listing of Parameters That Can Produce Meaningful Data During Monitoring Period.....	7-39
Table 7-6.	Parameters That Can Be Measured Without Violating Repository Integrity.....	7-40
Table 7-7.	Preclosure and Postclosure Monitored Parameters.....	7-40
Table 7-8.	Instrumentation Used in Support of the Geomechanical Monitoring System.....	7-46

Table 7-9.	Typical Environmental Surveillance Analysis Schedule	7-51
Table 7-9.	<i>Activities Related to the Implementation of the Permanent Markers Program</i>	7-75
Table 8-1.	Maximum Concentrations of Radionuclides Within the Salado Interbeds at the Disposal System Boundary <i>for the CCA Analysis</i>	8-4
Table 8-2.	<i>Maximum Concentrations of Radionuclides Within the Salado Interbeds at the Disposal System Boundary for the CRA Analysis</i>	8-5
Table 8-3 2.	Calculated Maximum Annual Committed Effective Doses <i>for the CCA Evaluation</i>	8-8
Table 8-3.	Parameter Values Listed in Appendix PAR	8-11
Table 8-4.	<i>Persons Per Household and Water Consumption Values Used in the CCA</i>	8-13
Table 8-5.	<i>Persons Per Household and Water Consumption Values Used in the CRA</i>	8-14
Table 8-4.	Total Inventory and Mass Loading of ²²⁶ Ra and ²²⁸ Ra	8-18
Table 8-6.	<i>Total Inventory and Mass Loading of ²²⁶Ra and ²²⁸Ra</i>	8-19
Table 9-1.	<i>Adequacy of WIPP Conceptual Models</i>	9-12
Table 9-2.	<i>Summary of the Peer Review of the EACBS Evaluation Factors and Criteria</i>	9-47
Table 9-3.	<i>Summary of Qualification Status of Parameters, as a Result of the Engineered Systems Peer Review</i>	9-57
Table 9-4.	<i>Summary of Parameters Reviewed and Qualification Status</i>	9-60
Table 9-5.	<i>Listing and Status of Reviewed Parameters</i>	9-63
Table 9-6.	<i>NAS WIPP Panel Reviews</i>	9-69
Table 9-7.	<i>Performance Assessment Peer Review Panel</i>	9-83
Table 9-8.	<i>Shaft Seal System Design Review</i>	9-85
Table 9-9.	<i>Engineered Alternatives Task Force Report Review</i>	9-88
Table 9-10.	<i>Blue Ribbon Panel Review</i>	9-91
Table 9-11.	<i>Advisory Committee on Nuclear Facility Safety</i>	9-94
Table 9-12.	<i>PART Independent Review of WIPP PA</i>	9-98
Table 9-13.	<i>INTRAVAL</i>	9-99
Table 9-14.	<i>Conceptual Model Uncertainty Group</i>	9-100
Table 9-15.	<i>EEG Reports</i>	9-103
Table 9-16.	<i>Fracture Expert Group</i>	9-124
Table 9-17.	<i>Fanghänel Review of the WIPP Thermodynamic Model for Trivalent Actinides</i>	9-126
Table 9-18.	<i>Independent Technical Review of the Bin and Alcove Test Programs at the WIPP</i>	9-129
Table 9-19.	<i>External Review of the WIPP PA Reports</i>	9-131
Table 9-20.	<i>Technical Support Group Reviews</i>	9-135
Table 9-21.	<i>NEPA Documentation Reviews</i>	9-138